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Oriented Unplasticized Polyvinyl Chloride (PVC-O) Pipes for Water Supply — Specification

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Plastic Piping System Sectional Committee, CED 50

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastic Piping System Sectional Committee had been approved by the Civil Engineering Divisional Council.

Unplasticized polyvinyl chloride pipes have been in use in India for water supply. New technology for manufacturing pipes, which involves process of controlling circumferential and axial orientation of molecular structure resulting in formation of laminar structure of the material used in the pipe construction, commonly named as PVC-O (Polyvinyl Chloride-Oriented) has been developed and now used in manufacturing of pipes. Manufacturing of pipes by this technology increases performance and strength of pipes. This standard has therefore been formulated to provide guidance to the manufacturers for manufacturing of pipes by this technology and to users for procurement and use of such pipes which are called oriented unplasticized polyvinyl chloride (PVC-O) pipes. This standard covers requirements for PVC-O pipes for water supply intended to be used underground, or above ground but not exposed to direct sunlight.

In the formulation of this standard, considerable assistance has been derived from ISO 16422 : 2014 'Pipes and joints made of oriented unplasticized polyvinyl chloride (PVC-O) for the conveyance of water under pressure — Specification'. Following are the major deviation observed from ISO 16422 : 2014.

a) This standard specifies requirements of pipes for minimum required strength (MRS) values of 450 and 500 as per the existing manufacturing practices followed in India.
b) This standard specifies requirements of pipes manufactured by considering two service (design) coefficients,that is, 1.4 and 1.6, as presently only these two service (design) coefficients are used in manufacturing of PVC-O pipes in India.
c) An additional pipe size of DN1200, which is not covered in ISO 16422 : 2014has been included in this standard as per the requirement expressed by the users.
d) An operating temperature of 27°C has been taken as a reference temperature, after applying derating factor due to Indian conditions; wall thickness dimensions specified are at variance from ISO 16422 : 2014. The tolerances on wall thickness are based on ISO 11922-1:1997 'Thermoplastics pipes for the conveyance of fluids - Dimensions and tolerances — Part 1: Metric series, Grade W'.
e) Testing of compound mix used in manufacturing of pipes for its conformity for minimum required strength requirements, which require testing time of 10 000 h is not covered in view of limited testing facility available at present in the country. The test will be considered for incorporation after three years of publication of this standard.

The classification of pipes depends on material compound/formulation used and stretch ratios. Therefore, with this classification system, it is desirable that the characteristics of compound/formulation may be ensured by manufacturer of pipes before use of material in manufacturing of pipes. It is suggested that variations in stretch ratios during manufacturing of pipes should be within 10 percent of the value observed in the material selected as above. Informative annex for determination of the stretch ratios is given at Annex E. Also, an informative annex for providing guidelines for the storage and installations of PVC-O pipes is given at Annex H.

This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices during manufacture of these pipes and determine the applicability of regulatory safety and health practices and limitations.

The composition of the Committee responsible for the formulation of this standard is given at Annex J.

For the purpose of deciding whether a particular requirement of this standard is complied withthe final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ORIENTED UNPLASTICIZED POLYVINYL CHLORIDE (PVC-O) PIPES FOR WATER SUPPLY — SPECIFICATION

1 SCOPE

1.1 This standard specifies the requirements of Oriented Unplasticized Polyvinyl Chloride (PVC-O) Pipes, for piping systems intended to be used underground,or above ground but not exposed to direct sunlight, for water supply. This standard covers requirements for pipes of sizes 63 mm to 1 200 mm with maximum required strength (MRS) class 450 and 500 and design coefficient of 1.4 and 1.6.

1.2 The piping system according to this standard is intended for the conveyance of cold water under pressure and are suitable for conveyance of water, including potable water, up to and including 45 °C and especially in those applications where special performance requirements are needed, such as impact loads and pressure fluctuations, up to pressure of 2.5 MPa.

1.3 Joints constructed of other materials should meet requirements of relevantstandards in addition to the fitness-for-purpose requirements of this standard.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard, the following terms and definitions shall apply.

3.1 Nominal Outside Diameter (d_n) — Numerical designation of size which is common to all components in a thermoplastics piping system other than flanges andcomponents designated by thread size.

3.2 Outside Diameter at Any Point (d_e) — Value of the measurement of the outside diameter through its cross-section at any point of a pipe or spigot, rounded up to the nearest 0.1 mm.

3.3 Mean Outside Diameter (d_{em}) — Value of the measurement of the outer circumference of a pipe or spigot end of a fitting in any cross-section, divided by π ($\approx$ 3.142), rounded up to the nearest 0.1 mm.

3.4 Minimum Outside Diameter ($d_{em\ min}$) — The minimum value of the mean outside diameter as specified in this standard. The value is equal to the nominal outside diameter d_n and is expressed in mm.

3.5 Maximum Outside Diameter ($d_{em\ max}$) — The maximum value of the mean outside diameter as specified in this standard.

3.6 Inside Diameter at any Point of a Pipe Socket (d_i) — Value of the measurement of the inside diameter through its cross-section at any point of a pipe socket, rounded up to the nearest 0.1 mm.

3.7 Nominal Wall Thickness (e_n) — Specified wall thickness, in mm.

NOTE — It is identical to the specified minimum wall thickness at any point $e_{y,min.}$

3.8 Out of Roundness (Ovality) — The difference between the measured maximum and the measured minimum outside diameter in the same cross-section of the pipe or spigot.

3.9 Tolerance — Permitted variation of the specified value of a quantity expressed as the difference between the permitted maximum and the permitted minimum value.

3.10 Nominal Pressure (*PN*) — Alphanumeric designation related to the mechanical characteristics of the components of a piping system and used for reference purposes.

3.11 Hydrostatic Pressure (*p*) — Internal pressure applied to a piping system.

3.12 Working Pressure — Maximum pressure which a piping system can sustain in continuous use under given service conditions without pressure surge.

NOTE — For thermoplastics piping systems, the value of the nominal pressure is equal to the working pressure at a temperature of 27°C, expressed in kg/cm^2.

3.13 Hydrostatic Stress (σ) — Stress, expressed in MPa, induced in the wall of a pipe when it is subjected to internal water pressure.

NOTE — It is calculated using the following approximate equation:

$$\sigma = \frac{P\,(d_n - e_n)}{2e_n}$$

where

p = applied internal pressure, in MPa;

d_n = nominal outside diameter of the pipe, in mm; and

e_n = nominal wall thickness, in mm.

3.14 Long-Term Hydrostatic Strength for 50 Years

at 20°C (σ_{LTHS}) — Quantity with the unit of stress in MPa, which can be considered to be a property of the material under consideration.

NOTE — It represents the 97.5 percent lower confidence limit for the long-term hydrostatic strength and equals the predicted average strength at a temperature of 20°C and for a time of 50 years with internal water pressure.

3.15 Lower Confidence Limit of the Predicted Hydrostatic Strength (σ_{LPL}) — Quantity with the dimension of stress, which represents the 97.5percent lower confidence limit of the predicted hydrostatic strength for a single value at a temperature T and a time t.

NOTES

1 It is denoted as $\sigma_{LPL} = \sigma(T,t,0.975)$.

2 The value of this quantity is determined by the method given in IS 16462/ISO 9080.

3.16 Minimum Required Strength (MRS) — Required value of σ_{LPL} for a temperature T of 20°C and a time t of 50 years.

3.17 Design Coefficient (C) — Coefficient with a value greater than one, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in σ_{LPL}.

3.18 Orientation Factor — Factor related to the stretch ratio used in orientation processing.

3.18.1 *Axial Orientation Factor* — Ratio between the length of the test piece before heat treatment and the lowest measured length after the heat treatment (*see* **9.4**):

$$\lambda_a = \frac{L_o}{L_i}$$

3.18.2 *Circumferential Orientation Factor* — Ratio between the diameter of test piece before and after heat treatment (*see* **9.4**):

$$\lambda_c = \frac{(D_{em} - e_{em})}{(D_i - e_i)}$$

The orientation ratio in tangential direction is the lowest measured value.

3.19 Type Tests — Tests carried out whenever a change is made in the composition or in the size/series in order to establish the suitability and the performance capability of the pipe.

3.20 Acceptance Tests — Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

3.21 Virgin Material — Material in such form as granules or powder that has not been subjected to use or processing other than that required for its manufacture and to which no re-processed or recycled material have been added.

3.22 Own Rework Material — Material prepared from rejected unused pipes, including the trimmings from the production of pipes, which will be reprocessed in a manufacturer's plant by a process such as extrusion and for which the complete formulation is known.

3.23 Nominal Pipe Length (l) — Effective length of pipes excluding the depth of the socket.

4 SYMBOLS AND ABBREVIATED TERMS

4.1 Symbols

C = Overall service (design) coefficient
d_e = Outside diameter at any point
d_{em} = Mean outside diameter
d_i = Inside diameter at any point
d_{im} = Mean inside diameter of socket
d_n = Nominal outside diameter
e = Wall thickness at any point
e_m = Mean wall thickness
e_n = Nominal wall thickness
l = Nominal pipe length
f_A = Derating or uprating factor for application
f_T = Derating factor for temperatures
K = K-value
p = Hydrostatic pressure
p_T = Test pressure
PN = Nominal pressure
θ = Material density
σ = Hydrostatic stress
σ_s = Design stress
λ_a = Axial orientation factor
λ_c = Circumferential orientation factor
σ_{LPL} = Lower predicted confidence limit

4.2 Abbreviations

DN = Nominal size

MRS = Minimum required strength

PFA = Allowable operating pressure

PVC-O = Oriented unplasticized polyvinyl chloride

PVC-U = Unplasticized polyvinyl chloride

5 MATERIAL

5.1 The material from which the pipe is produced shall consist substantially of unplasticized polyvinyl chloride to which may be added only those additives that are needed to facilitate the manufacture of the pipe and the production of sound and durable pipe of good surface finish, mechanical strength and opacity under conditions of use. None of these additives shall be used separately or together in quantities sufficient to constitute a toxic, organoleptic or microbial growth hazard, or materially to impair the fabrication or welding properties of the pipe, or to impair its chemical and physical or mechanical properties (in particular long term mechanical strength and impact strength) as defined in this standard. The additives to be used shall be selected from IS 10148 and shall be uniformly dispersed.

5.2 Rework Material

The use of the manufacturer's own reprocessed material, produced during the manufacture and works testing of products and conforming to the material requirements of this standard, is permitted. Reprocessed or recycled material obtained from external sources shall not be used.

5.3 VCM Content

The monomer content (VCM content) in the resin shall be within the limits specified in **3.3.1** of IS 10151, when tested as per Annex A of IS 10151.

5.4 K-Value

The composition shall be based on PVC resin having a K-value of 64 or greater, when tested in accordance with IS 4669.

NOTE — A test report or conformity certificate may be obtained from the resin manufacturer for the VCM content (*see* **5.3**) and K-value (*see* **5.4**) of the resin being used, unless the same is tested in an independent laboratory. The frequency of this test report or conformity certificate shall be once in every three months.

5.5 Density

When determined in accordance with IS 12235 (Part 14), the density of the pipe shall be between 1.40 g/cc and 1.46 g/cc.

5.6 Material Classification

5.6.1 *MRS Value*

Oriented pipes made from a defined PVC-U compound and with a well-defined orientation level in circumferential and axial direction, shall be evaluated according to the procedures specified in IS16462/ISO 9080 on the basis of tests given in **9.1.1** (*see also* **5.6.3**). Based on the minimum required strength (MRS) values, the material shall be classified in accordance with Table 1.

Table 1 Material Classification, Design Coefficient and Design Stress
(*Clause* 5.6.1)

Sl No.	Minimum Required Strength (MRS) MPa	Pipe Material Classification Number	Design Coefficient, C	Design Stress, σ_s = MRS/C MPa
(1)	(2)	(3)	(4)	(5)
i)	45.0	450	1.4	32
			1.6	28
ii)	50.0	500	1.4	36
			1.6	31

5.6.2 *Design Coefficient*

The design coefficient of PVC-O pipes shall be either 1.4 or 1.6 as specified by the manufacturer (*see* Table 1).

5.6.3 *Design Stress*

The design stress shall be based on the value of the lower confidence limit σ_{LPL} of the long term hydrostatic strength for the resistance to internal pressure as determined in accordance with IS 16462/ISO 9080.

This σ_{LPL} value shall be converted into a minimum required strength (MRS) in accordance with IS 16130/ ISO 12162. The MRS shall be divided by an overall service (design) coefficient, C to give the design stress σ_s, which is expressed by the following equation:

$$\sigma_s = \frac{MRS}{C}$$

6 CLASSIFICATION OF PIPES

The pipes shall be classified by their pressure rating (Nominal Pressure) (*PN*) at 27 °C, and their material class classification and design coefficient, as per Table 2.

7 GENERAL REQUIREMENTS OF PIPES

7.1 Visual Appearance

When checked without magnification glass, the internal and external surfaces of the pipe shall be smooth, clean, and free from scoring, cavities and other surface defects. Slight shallow longitudinal grooves or irregularities in the pipe shall be permissible provided the wall thickness remains within the permissible limits. The material shall not contain visible impurities. The ends of the pipe shall be either cut cleanly and reasonably square to the axis of the pipe or chamfered at the plain end at approximately 15° to the axis of the pipe (*see* **8.3** and Fig. 1).

7.2 Colour

The colour of the pipes shall be any shade of grey, blue or cream. The pipes may also be supplied in any other colour as agreed tobetween the manufacturer and thesupplier. Slight variations in the appearance of the colour may be permitted.

7.3 Opacity

The wall of the pipe shall not transmit more than 0.2 percent of the visible light falling on it, when tested in accordance with IS 12235 (Part 3).

8 GEOMETRICAL CHARACTERISTICS OF PIPES

8.1 Dimension of Pipes

8.1.1 *Diameter*

The nominal outside diameter, outside diameter at any

Table 2 Pressure Rating and Working Pressure of Pipes

(*Clause* 6)

Sl No.	**Design Coefficient** *C*	**Pressure Rating (*PN*)**									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	*For Material Classification - Class 450*:										
a)	1.4	PN 10	–	PN 12.5	–	PN 16	–	PN 20	–	PN 25	–
b)	1.6	–	PN 10	–	PN 12.5	–	PN 16	–	PN 20	–	PN 25
ii)	*For Material Classification - Class 500*:										
a)	1.4	–	PN 12.5	–	PN 16	–	PN 20	–	PN 25	–	–
b)	1.6	PN 10	–	PN 12.5	–	PN 16	–	PN 20	–	PN 25	–

Working pressure corresponding to various pressure ratings:

Pressure Rating	*Working Pressure*
PN 10	1.0 Mpa (10 kg/cm^2)
PN 12.5	1.25 Mpa (12.5 kg/cm^2)
PN 16	1.6 Mpa (16 kg/cm^2)
PN 20	2.0 Mpa (20 kg/cm^2)
PN 25	2.5 Mpa (25 kg/cm^2)

NOTE — The above pipes are recommended for water temperatures ranging from 1 °C to 45 °C. At temperatures higher than 27 ºC and up to 45 ºC, the strength of the pipe reduces and the working pressure shall therefore be modified using the derating factor as obtained from the graph given in Annex B. Occasional rise in temperature as in summer season with concurrent corresponding reduction in temperature during nights has no deleterious effect on the life/working pressure of the pipes considering the total life of pipes.

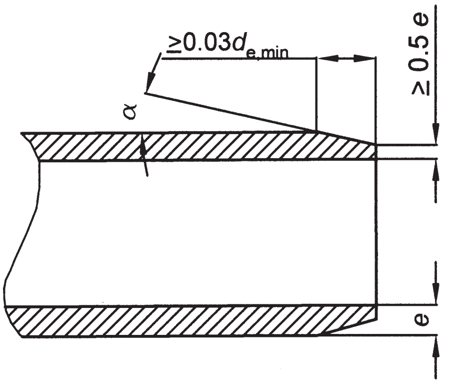


FIG. 1 SPIGOT END FOR PIPES WITH ELASTOMERIC SEALING RING

point and their tolerances shall be as given in Table 3 and shall be measured according to the method given in IS 12235 (Part 1).

8.1.1.1 *Nominal outside diameter*

The permissible variation (d_{em} - d_n) between the mean outside diameter (d_{em}) and the nominal outside diameter (d_n) of a pipe shall be positive in the form +x, where x is less than or equal to the greater of the following two values:

a) 0.3 mm, and
b) $0.003d_n$ rounded off to the next higher 0.1 mm with maximum value of 2.0 mm.

8.1.1.2 *Diameter at any point*

The permissible variation between the outside diameter at any point (d_e) and the nominal diameter (d_n) of a pipe (also called tolerance on ovality) shall not exceed the greater of the following two values:

a) 0.5 mm, and
b) $0.012d_n$ rounded off to the next higher 0.1 mm.

Table 3 Outside Diameters and Tolerances

(*Clause* 8.1.1)

All dimensions in millimetres.

Sl No.	Nominal Outside Diameter, d_n	Mean Outside Diameter, d_{em}		Outside Diameter at Any Point, d_e	
		Min	*Max*	*Min*	*Max*
(1)	(2)	(3)	(4)	(5)	(6)
i)	63	63.0	63.3	62.2	63.8
ii)	75	75.0	75.3	74.1	75.9
iii)	90	90.0	90.3	88.9	91.1
iv)	110	110.0	110.4	108.6	111.4
v)	125	125.0	125.4	123.5	126.5
vi)	140	140.0	140.5	138.3	141.7
vii)	160	160.0	160.5	158.0	162.0
viii)	180	180.0	180.6	177.8	182.2
ix)	200	200.0	200.6	197.6	202.4
x)	225	225.0	225.7	222.3	227.7
xi)	250	250.0	250.8	247.0	253.0
xii)	280	280.0	280.9	276.6	283.4
xiii)	315	315.0	316.0	311.2	318.8
xiv)	355	355.0	356.1	350.7	359.3
xv)	400	400.0	401.2	395.2	404.8
xvi)	450	450.0	451.4	444.6	455.4
xvii)	500	500.0	501.5	494.0	506.0
xviii)	560	560.0	561.7	553.2	566.8
xix)	630	630.0	631.9	622.4	637.6
xx)	710	710.0	712.0	701.4	718.6
xxi)	800	800.0	802.0	790.4	809.6
xxii)	900	900.0	902.0	889.2	910.8
xxiii)	1 000	1 000.0	1 002.0	988.0	1 012.0
xxiv)	1 200	1 200.0	1 202.0	1 185.6	1 214.4

8.1.2 *Wall Thickness*

The wall thickness of the pipes shall conform to values specified in Tables 4 to 7.

The wall thickness shall be measured as per any test method specified in IS 12235 (Part 1). The wall thickness of the pipe at any point shall confirm to the above requirement within tolerance specified at **8.1.2.1**.

NOTES

1 The wall thickness at any point may be measured either by cutting the pipe or by non-destructive method using suitable measuring instrument of desired least count and accuracy such as the use of ultrasonic wall thickness measurement gauge, etc.

2 The wall thicknesses have been calculated after applying a de-rating factor of 0.95 in view of standard temperature considered as 27°C.

8.1.2.1 *Tolerance on wall thickness*

The tolerance on nominal wall thickness, +y

Table 4 Wall Thicknesses for Material Class 450/C 1.4

(*Clause* 8.1.2)

Sl No.	Nominal Diameter, d_n mm	Class 450/*C*= 1.4 Wall Thickness, e_n mm				
		Nominal Pressure, PN				
		10	12.5	16	20	25
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	63	1.1	1.3	1.7	2.1	2.6
ii)	75	1.3	1.6	2.0	2.4	3.1
iii)	90	1.5	1.9	2.4	2.9	3.7
iv)	110	1.8	2.3	2.9	3.6	4.5
v)	125	2.1	2.6	3.3	4.0	5.1
vi)	140	2.3	2.9	3.6	4.5	5.7
vii)	160	2.6	3.3	4.2	5.1	6.5
viii)	180	3.0	3.7	4.7	5.8	7.3
ix)	200	3.3	4.1	5.2	6.4	8.1
x)	225	3.7	4.6	5.8	7.2	9.1
xi)	250	4.1	5.1	6.5	8.0	10.2
xii)	280	4.6	5.7	7.2	9.0	11.4
xiii)	315	5.1	6.4	8.1	10.1	12.8
xiv)	355	5.8	7.2	9.2	11.4	14.4
xv)	400	6.5	8.1	10.3	12.8	16.2
xvi)	450	7.4	9.3	11.6	14.4	18.2
xvii)	500	8.2	10.4	12.9	16.0	20.3
xviii)	560	9.2	11.6	14.4	17.9	22.7
xix)	630	10.3	13.0	16.2	20.1	25.5
xx)	710	11.6	14.7	18.3	22.7	28.7
xxi)	800	13.1	16.5	20.6	25.5	32.4
xxii)	900	14.7	18.6	23.1	28.7	36.4
xxiii)	1 000	16.4	20.7	25.7	31.9	40.5
xxiv)	1 200	19.6	24.8	30.8	38.3	48.5

Table 5 Wall Thicknesses for Material Class 500/C 1.4

(*Clause* 8.1.2)

Sl No.	Nominal Diameter, d_n mm	Class 500/*C*= 1.4 Wall Thickness, e_n mm Nominal Pressure, PN			
		12.5	16	20	25
(1)	(2)	(3)	(4)	(5)	(6)
i)	63	1.2	1.5	1.8	2.3
ii)	75	1.4	1.8	2.2	2.7
iii)	90	1.7	2.1	2.6	3.3
iv)	110	2.0	2.6	3.2	4.0
v)	125	2.3	2.9	3.6	4.5
vi)	140	2.6	3.2	4.0	5.1
vii)	160	2.9	3.7	4.6	5.8
viii)	180	3.3	4.2	5.2	6.5
ix)	200	3.6	4.6	5.7	7.2
x)	225	4.1	5.2	6.4	8.1
xi)	250	4.5	5.8	7.2	9.0
xii)	280	5.1	6.4	8.0	10.1
xiii)	315	5.7	7.2	9.0	11.4
xiv)	355	6.4	8.2	10.1	12.8
xv)	400	7.2	9.2	11.4	14.4
xvi)	450	8.3	10.3	12.8	16.2
xvii)	500	9.2	11.4	14.2	18.0
xviii)	560	10.3	12.8	15.9	20.2
xix)	630	11.6	14.4	17.9	22.7
xx)	710	13.1	16.2	20.2	25.6
xxi)	800	14.7	18.3	22.7	28.8
xxii)	900	16.5	20.6	25.5	32.4
xxiii)	1 000	18.4	22.8	28.4	36.0
xxiv)	1 200	22.0	27.4	34.0	43.2

[*see* **8.1.2.1**(a)], shall as specified below unless these are specified by the manufacturer:

a) The permissible variation between the minimum wall thickness (e_{min}) and the wall thickness at any point (e), ($e - e_{min}$) shall be positive in the form of $+y$, where $y = 0.1e_{min}+0.2$ mm, and as per Table 8.

b) The average wall thickness shall be determined by taking at least six measurements of wall thickness round the pipe and including both the absolute minimum and absolute maximum measured values.

c) The results of these calculations for checking tolerance shall be rounded off to the next higher 0.1 mm.

NOTE — Due to the additional processing step of the orientation of the material, the spread on mean wall thickness of the PVC-O pipe could be increased.

8.1.3 *Length*

The pipes shall be supplied with the length not less than the declared nominal pipe length. It is recommended that the nominal pipe length to be supplied may be 6 m, 10 m and 12 m. The pipes may be supplied in other lengths where so agreed upon between the manufacturer and the purchaser.

8.2 Dimensions of Integral Socket

The minimum depth of engagement of integral sockets with elastomeric sealing ring type joints shall conform to Table 9.

Attention is drawn to the fact that the depths of engagement required by Table 9 could be insufficient for PVC-O pipes under certain circumstances. It is recommended that the suitability of depth of engagement be verified. In Annex C, an example for the calculation of depth of engagement is given.

NOTE — There is no minimum wall thickness requirement for sealing ring type sockets. It is considered as being more relevant to verify the strength of the sockets as being at least the same as the strength of the pipe in accordance with **9.1.2**.

8.3 Pipe Ends

Pipes with plain end(s) to be used with elastomeric sealing ring type joints shall have a chamfer at the plain

Table 6 Wall Thicknesses for Material Class 450/C = 1.6

(*Clause* 8.1.2)

Sl No.	Nominal Diamter, d_n mm	Class 450/*C*= 1.6 Wall Thickness, e_n mm Nominal Pressure, PN				
		10	12.5	16	20	25
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	63	1.2	1.5	1.8	2.3	2.9
ii)	75	1.4	1.8	2.2	2.7	3.4
iii)	90	1.7	2.1	2.6	3.3	4.1
iv)	110	2.0	2.6	3.2	4.0	5.0
v)	125	2.3	2.9	3.6	4.5	5.6
vi)	140	2.6	3.2	4.0	5.1	6.3
vii)	160	2.9	3.7	4.6	5.8	7.2
viii)	180	3.3	4.2	5.2	6.5	8.1
ix)	200	3.6	4.6	5.7	7.2	9.0
x)	225	4.1	5.2	6.4	8.1	10.1
xi)	250	4.5	5.8	7.2	9.0	11.2
xii)	280	5.1	6.4	8.0	10.1	12.5
xiii)	315	5.7	7.2	9.0	11.4	14.1
xiv)	355	6.4	8.2	10.1	12.8	15.9
xv)	400	7.2	9.2	11.4	14.4	17.9
xvi)	450	8.3	10.3	12.8	16.2	20.1
xvii)	500	9.2	11.4	14.2	18.0	22.3
xviii)	560	10.3	12.8	15.9	20.2	25.0
xix)	630	11.6	14.4	17.9	22.7	28.1
xx)	710	13.1	16.2	20.2	25.6	31.7
xxi)	800	14.7	18.3	22.7	28.8	35.7
xxii)	900	16.5	20.6	25.5	32.4	40.2
xxiii)	1 000	18.4	22.8	28.4	36.0	44.6
xxiv)	1 200	22.0	27.4	34.0	43.2	53.5

Table 7 Wall Thicknesses for Material Class 500/C = 1.6

(*Clause* 8.1.2)

Sl No.	Nominal Diameter, d_n mm	Class 500/C = 1.6 Wall Thickness, e_n mm Nominal Pressure, PN				
		10	12.5	16	20	25
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	63	1.1	1.3	1.7	2.1	2.6
ii)	75	1.3	1.6	2.0	2.4	3.1
iii)	90	1.5	1.9	2.4	2.9	3.7
iv)	110	1.8	2.3	2.9	3.6	4.5
v)	125	2.1	2.6	3.3	4.0	5.1
vi)	140	2.3	2.9	3.6	4.5	5.7
vii)	160	2.6	3.3	4.2	5.1	6.5
viii)	180	3.0	3.7	4.7	5.8	7.3
ix)	200	3.3	4.1	5.2	6.4	8.1
x)	225	3.7	4.6	5.8	7.2	9.1
xi)	250	4.1	5.1	6.5	8.0	10.2
xii)	280	4.6	5.7	7.2	9.0	11.4
xiii)	315	5.1	6.4	8.1	10.1	12.8
xiv)	355	5.8	7.2	9.2	11.4	14.4
xv)	400	6.5	8.1	10.3	12.8	16.2
xvi)	450	7.4	9.3	11.6	14.4	18.2
xvii)	500	8.2	10.4	12.9	16.0	20.3
xviii)	560	9.2	11.6	14.4	17.9	22.7
xix)	630	10.3	13.0	16.2	20.1	25.5
xx)	710	11.6	14.7	18.3	22.7	28.7
xxi)	800	13.1	16.5	20.6	25.5	32.4
xxii)	900	14.7	18.6	23.1	28.7	36.4
xxiii)	1 000	16.4	20.7	25.7	31.9	40.5
xxiv)	1 200	19.6	24.8	30.8	38.3	48.5

end at approximately 15° to the axis of the pipe conforming to Fig. 1 (α to be approximately 15°).

9 MECHANICAL CHARACTERISTICS OF PIPES

9.1 Resistance to Hydrostatic Pressure

9.1.1 *Pipes*

Resistance to hydrostatic pressure shall be verified using the induced stresses derived from the analysis of the test data in accordance with IS 16462/ISO 9080. For a period of 10 h at 27 °C and 1 000 h at 27 °C, the 99.5 percent LPL value shall be taken as the minimum stress level.

For a period of 1 000 h at 60 °C, the 99.5 percent LPL value established from analysis of test data at 60 °C in accordance with IS 16462/ISO 9080 can be taken as the minimum stress level. In case of lack of data, alternatively, a value of 0.625 times the MRS value shall be taken as the minimum stress level.

When tested using either end cap Type A or Type B in accordance with IS 12235(Part 8/Sec 1), and using the combinations of test temperatures and induced stresses so derived, the pipe shall not fail in less than the times stated above.

Table 8 Tolerance on Wall Thickness

(*Clause* 8.1.2.1)

All dimensions in millimetres.

Sl No.	Minimum Wall Thickness $e_{\min}$		Tolerance $+y$
	>	≤	
(1)	(2)	(3)	(4)
1)	–	1.0	0.3
2)	1.0	2.0	0.4
3)	2.0	3.0	0.5
4)	3.0	4.0	0.6
5)	4.0	5.0	0.7
6)	5.0	6.0	0.8
7)	6.0	7.0	0.9
8)	7.0	8.0	1.0
9)	8.0	9.0	1.1
10)	9.0	10.0	1.2
11)	10.0	11.0	1.3
12)	11.0	12.0	1.4
13)	12.0	13.0	1.5
14)	13.0	14.0	1.6
15)	14.0	15.0	1.7
16)	15.0	16.0	1.8
17)	16.0	17.0	1.9
18)	17.0	18.0	2.0
19)	18.0	19.0	2.1
20)	19.0	20.0	2.2
21)	20.0	21.0	2.3
22)	21.0	22.0	2.4
23)	22.0	23.0	2.5
24)	23.0	24.0	2.6
25)	24.0	25.0	2.7
26)	25.0	26.0	2.8
27)	26.0	27.0	2.9
28)	27.0	28.0	3.0
29)	28.0	29.0	3.1
30)	29.0	30.0	3.2
31)	30.0	31.0	3.3
32)	31.0	32.0	3.4
33)	32.0	33.0	3.5
34)	33.0	34.0	3.6
35)	34.0	35.0	3.7
36)	35.0	36.0	3.8
37)	36.0	37.0	3.9
38)	37.0	38.0	4.0
39)	38.0	39.0	4.1
40)	39.0	40.0	4.2
41)	40.0	41.0	4.3
42)	41.0	42.0	4.4
43)	42.0	43.0	4.5
44)	43.0	44.0	4.6
45)	44.0	45.0	4.7
46)	45.0	46.0	4.8
47)	46.0	47.0	4.9
48)	47.0	48.0	5.0
49)	48.0	49.0	5.1
50)	49.0	50.0	5.2

Table 9 Dimensions of Sockets for Elastomeric Sealing Ring Joints

(*Clause* 8.2)

All dimensions in millimetres.

Sl No.	Nominal Diameter, d_n	Minimum Depth of Engagement, m_{min}[1)]	Minimum Mean Inside Diameter of Socket, $d_{im\ min}$
(1)	(2)	(3)	(4)
i)	63	58	63.4
ii)	75	60	75.4
iii)	90	61	90.4
iv)	110	64	110.5
v)	125	66	125.5
vi)	140	68	140.6
vii)	160	71	160.6
viii)	180	73	180.7
ix)	200	75	200.7
x)	225	78	225.8
xi)	250	81	250.9
xii)	280	85	281.0
xiii)	315	88	316.1
xiv)	355	90	356.2
xv)	400	92	401.3
xvi)	450	95	451.5
xvii)	500	97	501.6
xviii)	560	101	561.8
xix)	630	105	632.0
xx)	710	109	712.1
xxi)	800	114	802.1
xxii)	900	120	902.1
xxiii)	1 000	125	1002.1
xxiv)	1 200	136	1202.1

[1)] The value of m_{min} is calculated from the equations given below and as applicable:

$m_{min} = 50\text{ mm} + 0.22d_n - 2e$ when $d_n \leq 280$, and

$m_{min} = 70\text{ mm} + 0.15d_n - 2e$ when $d_n > 280$.

The value obtained shall be rounded to the next greater 1 mm.

The test shall be carried out not earlier than 24 h after the pipes have been manufactured.

NOTE — All pipes that meet the requirements of Table10 are deemed to meet the MRS requirements till the time of implementation of IS 16462/ISO 9080 in this standard.

Table 10 Test Parameters for the Determination of Resistance to Internal Hydrostatic Pressure

(*Clause* 9.1.1)

Sl No.	Test	Temperature, *Min*	Duration, *Min*	Circumferential Stress/ Hoop Stress, σ	
		°C	h	MPa	
				PVC-O 450	PVC-O 500
(1)	(2)	(3)	(4)	(5)	(6)
i)	Acceptance	27	10	57	62
ii)	Type	60	1 000	28	31

9.1.2 *Pipes with Integral Socket*

Pipes when tested in accordance with IS 12235 (Part 8), usingthe test procedure as given in **9.1.1**, integral sealing ring sockets formed on pipes shall not fail in less than the time according to **9.1.1**. Sockets will be tested only to the acceptance test (27 ºC and 10 h). The length of the pipe section shall meet the requirements or specification given in **9.1.1**. Failure shall not occur in either pipe or socket sections.

9.2 Resistance to External Blows at 0 °C

Pipes when tested at 0°C in accordance with IS 12235 (Part 9) using striker mass as given in col 3 of Table 11 and drop height for various nominal sizes as per col 4 of Table 11, shall have a true impact rate (TIR) of not more than 10 percent. The radius of the striker nose, *R* shall be 12.5 mm.

In case of socket ended pipes, this test shall be carried out on the plain portion of the pipes taken atleast 100 mm away from the route of the socket.

Table 11 Classified Striker Mass and Drop Height Conditions for the Falling-Weight Impact Test

(*Clause* 9.2)

Sl No.	Nominal Diameter, d_n	Total Mass	Drop Height
	mm	kg	m
(1)	(2)	(3)	(4)
i)	63	4	2.0
ii)	75	5	2.0
iii)	90	5	2.0
iv)	110	6.3	2.0
v)	125	6.3	2.0
vi)	140	8	2.0
vii)	160	8	2.0
viii)	180	10	2.0
ix)	200	10	2.0
x)	≥ 225	12.5	2.0

NOTE — Impact characteristics can change over time. These values are applicable only at the time of manufacture.

9.3 Ring Stiffness

Theminimum value of ring stiffness of pipes when determined in accordance with IS 12235 (Part 18) shall be as specified in Table12.

9.4 Orientation Factor

The determination of the stretch ratios (axial orientation factor and circumferential orientation factor) may be carried out as per Annex E.

NOTE — When determining the orientation degrees in the circumferential and axial direction of the pipe, use is made of the fact that the oriented pipe in the rubber phase (above the glass/rubber transition temperature) will shrink till the initial dimensions determined by the extrusion process.

Table 12 Ring Stiffness of Pipes
(*Clause* 9.3)

Sl No.	Nominal Diameter, d_n mm	Ring Stiffness[1] kN/m^2	Ring Stiffness[2] (For Specific Jointing Techniques) kN/m^2
(1)	(2)	(3)	(4)
i)	63	≥ 6	≥ 20
ii)	75		≥ 12
iii)	90		≥ 10
iv)	110	≥4	≥ 10
v)	125		≥ 8
vi)	140		≥ 7
vii)	160		≥ 7
viii)	≥200		≥ 6

[1] Pipes of stiffness less than 4 kN/m^2 might not be suitable where high vacuum or external pressure could be developed, and could need special installation techniques where installed below ground.

[2] Due to specific jointing techniques in water supply and installation below ground, higher stiffness may be needed.

NOTE — Minimum stiffness of pipes could be required for installation with some type of fittings. The sample calculation for calculating nominal stiffness of the pipes is given in Annex D.

10 PHYSICAL AND CHEMICAL CHARACTERISTICS

When tested in accordance with the test methods as specified in Table 13 using the parameters indicated therein, the pipe shall have physical and chemical characteristics conforming to the requirements given in Table 13.

11 MECHANICAL CHARACTERISTICS OF ASSEMBLIES INCLUDING JOINTS

11.1 Assemblies with Non-End-Load-Bearing Joints

The following types of assemblies with non-end-load-bearing joints shall fulfil the fitness for purpose requirements given in **11.2** to **11.4** and Tables 14, 15 and 16 as applicable:

a) Integrally socketed PVC-O pipe to pipe assemblies with elastomeric ring seal joints conforming to this standard;
b) Metal fitting and PVC-O pipe assemblies with elastomeric ring seal joints;
c) Metal valve and PVC-O pipe assemblies with elastomeric ring seal joints; and
d) Mechanical joint assemblies with PVC-O pipes.

11.2 Short-Term Pressure Test for Leak Tightness of Assemblies

11.2.1 *Test Procedure*

When an assembly with one or more elastomeric sealing ring type joints is tested using a hydrostatic pressure and angular deflection in accordance with IS 12235 (Part 8/Sec 2), and the test conditions given in Table 14, the assembly shall conform to the requirement given in Table 14.

11.2.2 *Test Pressure*

The test pressures P_T shall be calculated by using the following equation:

$$P_T = f \times PN \times f_t$$

where

PN = nominal pressure,
f = multiplying factor (to be obtained from Fig. 2),
P_T = test pressure, and
f_t = de-rating factor.

11.3 Short-Term Negative Pressure Test for Leak Tightness of Assemblies

When an assembly with one or more elastomeric sealing ring type joints is tested using a negative pressure with angular deflection and the deformation in accordance with IS 12235 (Part 8/Sec 3), and the test conditions given in Table 15, the assembly shall conform to the

Table 13 Physical and Chemical Characteristics
(*Clause* 10)

Sl No.	Characteristic	Requirement	Test Parameters	Test Method, Ref to
(1)	(2)	(3)	(4)	(5)
i)	Vicat softening temperature [1]	≥ 80 °C	Shall conform to IS 12235 (Part 2), and Number of test pieces = 3	IS 12235 (Part 2)
ii)	Effect on water	As per IS 4985	IS 12235 (Part 4) and IS 12235 (Part 10)	IS 12235 (Part 4) and IS 12235 (Part 10)
iii)	Resistance to Di-chloromethane at a specific temperature (Degree of gelation)[1]	No attack at any part of the surface of the test piece	Temperature of bath = 15 ± 1 °C, immersion time = 15 min, and minimum wall thickness = 1.5 mm.	IS 12235 (Part11)
iv)	Alternative testto resistance to di-chloromethanetest: Uni-axial tensile test	Minimum stress 48 MPa	In accordance with IS 12235 (Part 13)	IS 12235 (Part 13)

[1] To be carried out on feedstock pipe or on reverted pipe.

Table 14 Test Conditions and Requirements for Short-Term Assembly Test

(*Clause* 11.2.1)

Sl No.	Test Temperature °C	Test Pressure MPa	Test Time min	Test Requirement
(1)	(2)	(3)	(4)	(5)
i)	*T* = 2 (where *T* is any temperature between 20°C and 27°C)	Pressure is calculated in accordance with Fig. 2 and **11.2.2**	One cycle in accordance with Fig. 2	No leakage at any point of the jointing areas throughout the whole test cycle

NOTE — The pressure changes from one pressure level to the next shall take place within the periods indicated, but need not take place at strictly linear rates.

requirement given in Table 15. Procedure for calculating negative pressure capability of pipes for different class and design coefficient is given in Annex F.

11.4 Long-Term Pressure Test for Leak Tightness

When an assembly with one or more joints selected from elastomeric sealing ring type sockets and other end-load-bearing and non-end-load-bearing joints for oriented PVC-U components for a piping system is tested in accordance with IS 12235 (Part 8/Sec 4), using the test conditions given in Table 16 for the test temperatures of 27°C and 40°C, the assembly shall conform to the requirement given in Table 16.

Table 16 Test Requirement for the Long-Term Pressure Testing of Assembled Joints

(*Clause* 11.4)

Sl No.	Test Temperature °C	Test Pressure [1] MPa	Test Time h	Test Requirement
(1)	(2)	(3)	(4)	(5)
i)	27	1.3 *PN*	1 000	No leakage at any point of the jointing areas at least for the test time
ii)	40	1.1 *PN*	1 000	

[1] The PN rating to be taken to calculate the test pressure shall be the PN rating of the fitting, and if pipe with an integral joint is being tested, it shall be the PN rating of the pipe.

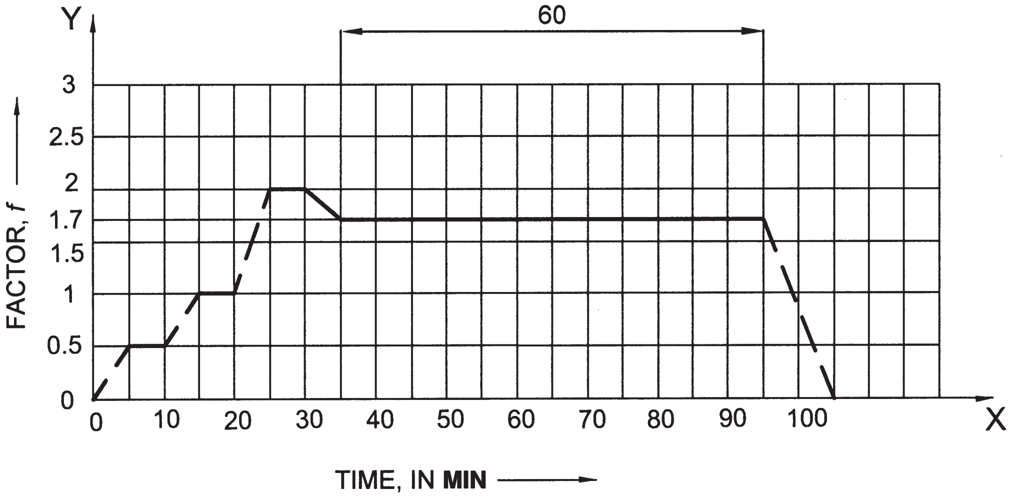


FIG. 2 HYDROSTATIC PRESSURE TEST REGIME

Table 15 Test Conditions and Requirements for Short-Term Negative-Pressure Assembly Test

(*Clause* 11.3)

Sl No.	Test Temperature °C	Test Pressure MPa	Test Time min	Test Requirement
(1)	(2)	(3)	(4)	(5)
i)	T ± 2 where *T* is any temperature between 20°C and 27°C	Pressure calculated in accordance with Fig. 3	One cycle in accordance with Fig. 3	The change in negative pressure shall be not more than 0.005 MPa during each 15 min test period shown in Fig. 3.

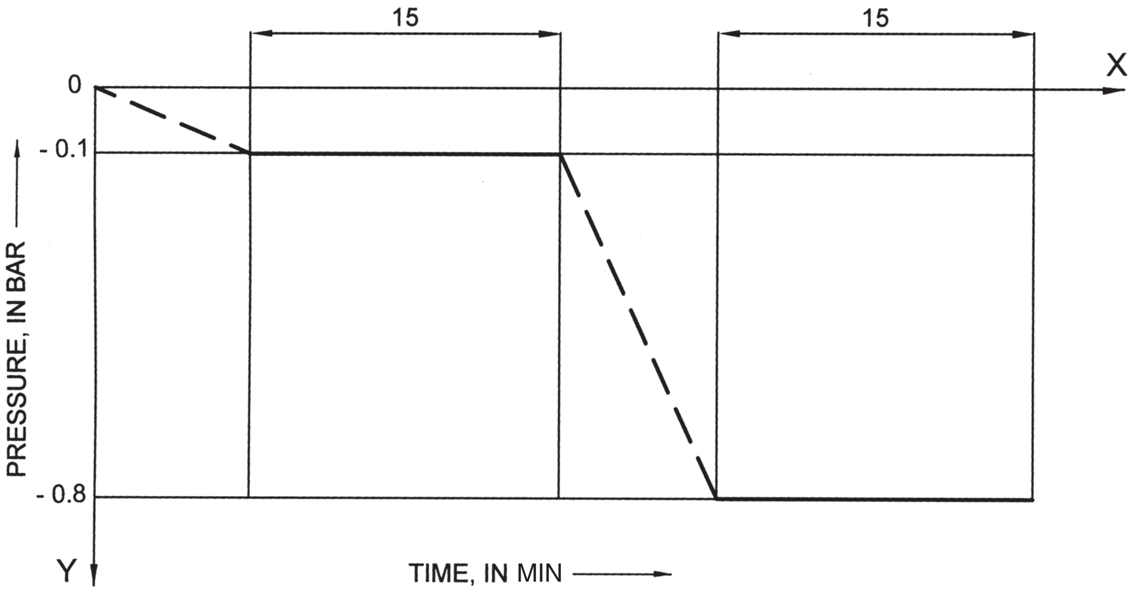
NOTES

1 The pressure change from one pressure level to the next, need not take place at strictly linear rates.

2 For pipes with integral sockets, there is no need for testing with angular deflection.

3 For pipes of ring stiffness less than 4 kN/m^2, it is allowed to support the pipe to avoid collapsing during testing.

4 Sample calculation and method to be adopted for calculation of negative pressure capability of the pipes is given at Annex F.



NOTE — 1 Bar = 0.1 MPa

FIG. 3 NEGATIVE-PRESSURE TEST REGIME

12 ELASTOMERIC SEALS

Elastomeric seals used for joining components shall conform to both the following requirements:

a) Rings shall conform to the material requirements specified in IS 5382.
b) Rings shall be free from chemical agents such as plasticizers that could have a detrimental effect on the pipes or fittings, or on the quality of the water.

13 SAMPLING AND CRITERIA FOR CONFORMITY

The sampling procedure and the criteria for conformity shall be as given in Annex G.

14 MARKING

14.1 Each pipe shall be clearly and indelibly marked in ink/paint or hot embossed on white base at an interval not more than 1 m. The markings shall include the following:

a) Manufacturer's name and/or trade-mark;
b) Pipe material and material classification number;
c) Nominal outside diameter, d_n;
d) Nominal pressure, *PN*;
e) Reference to this standard;
f) C-factor; and
g) Batch number.

For example: Marking may be as given below:

Trade-mark PVC-O 450 DN160 PN16 C1.6
Batch Number

14.1.1 The batch number shall include the details of production in the following manner:

Year	*Month*	*Day*	*Machine No.*	*Shift*
xxxx	xx	xx	xxx	xxx

14.2 BIS Certification Marking

Each pipe may also be suitably marked with the Standard Mark.

14.2.1 The use of Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act,* 1986 and the Rules and Regulations made thereunder. The details of conditions under which a license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
4669 : 1968	Methods of tests for polyvinyl chloride resin
4905 : 2015/ ISO 24153 : 2009	Random sampling and randomization procedures (*first revision*)
4985 : 2000	Unplasticized PVC pipes for potable water supplies — Specification (*third revision*)
5382 : 1985	Rubber sealing rings for gas mains, water mains and sewers (*first revision*)
10148 : 1982	Positive list of constituents of polyvinyl chloride resins and its copolymers for safe use in contact with foodstuffs, pharmaceuticals and drinking water
10151 : 1982	Specification for polyvinyl chloride (PVC) and its copolymers for its safe use in contact with foodstuffs, pharmaceuticals and drinking water
12235	Thermoplastics pipes and fittings — Methods of test (*first revision*)
(Part 1) : 2004	Measurement of dimensions
(Part 2) : 2004	Determination of Vicat softening temperature
(Part 3) : 2004	Test for opacity
(Part 4) : 2004	Determination of detrimental effect on the composition of water
(Part 5/Sec 1) : 2004	Longitudinal reversion, Section 1 Determination method
(Part 5/Sec 2) : 2004	Longitudinal reversion, Section 2 Determination parametres
(Part 8/Sec1) : 2004	Resistance to internal hydrostatic pressure, Section 1 Resistance to internal hydrostatic pressure at constant internal water pressure
(Part8/Sec2) : 2004	Resistance to internal hydrostatic pressure, Section 2 Leak-tightness of elastomeric sealing ring type socket joints underpositive internal pressure and with angular deflection
(Part 8/Sec 3) : 2004	Resistance to internal hydrostatic pressure, Section 3 Leak-tightness of elastomeric sealing ring type socket joints under negative internal pressure and with angular deflection
(Part 8/Sec 4) : 2004	Resistance to internal hydrostatic pressure, Section 4 Leak-tightness of elastomeric sealing ring type socket joints under positive internal pressure without angular deflection
(Part 9) : 2004	Resistance to external blows (impact resistance) at 0°C (round-the-clock method).
(Part 10) : 2004	Determination of organotin as tin aqueous solution
(Part 11) : 2004	Resistance to dichloromethane at specified temperature.
(Part 13) : 2004	Determination of tensile strength and elongation
(Part 14) : 2004	Determination of density/relative density (specific gravity)
(Part 18) : 2004	Determination of ring stiffness
15328 : 2003	Unplasticized non-pressure polyvinyl chloride (UPVC) pipes for use in underground drainage and sewerage system — Specification.
16130 : 2014/ ISO12162 : 2009	Thermoplastics materials for pipes and fittings for pressure applications — Classification and designation overall service (design) coefficient
16462 : 2016/ ISO 9080 : 2012	Plastic piping and ducting systems — Determination of the longterm hydrostatic strength of thermoplastics materials in pipe form by extrapolation

ANNEX B

(*Table* 2)

TEMPERATURE DE-RATING FACTOR

B-1 Temperature de-rating information given in Fig. 4 may be used as a guide unless real figures from manufacturers are available.

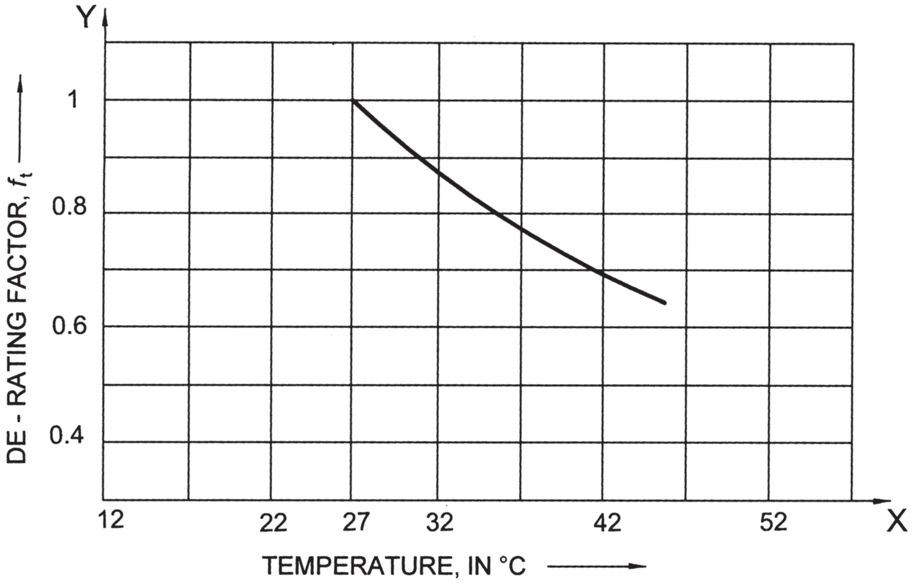


FIG. 4 DE-RATING FACTOR, f_T AS A FUNCTION OF OPERATING TEMPERATURE

ANNEXC

(*Clause* 8.2)

MINIMUM DEPTH OF ENGAGEMENT OF SOCKETS

C-1 GENERAL

The minimum depth of engagement of integral sockets with elastomeric sealing ring type joints is given in [**7.2.1.2**(a) and Table 5 of IS 4985]. Attention is drawn to the fact that the depths of engagement required by IS 4985 could be insufficient for PVC-O pipes under certain circumstances, particularly pipes of length greater than 6 m, and could result in pull-out and leakage under adverse conditions. Primarily, this is due to the higher strain levels developed at the higher operating stresses invoked in PVC-O pipes, compared with the PVC-U pipes covered in IS 4985.

The potential for pull-out also exists with short-socketed fittings of PVC or other materials used in conjunction with PVC-O pipes.

C-2 CALCULATION OF DEPTH OF ENGAGEMENT

C-2.1 Depth of engagement, *m*, is calculated by:

$$m = m_p + m_t + m_a + m_c + m_s$$

Where *m* is the sum of **C-2.2** to **C-2.6**.

C-2.2 Poisson Contraction

Shortening of length, m_p, in millimetres, when pressurized shall be as given below:

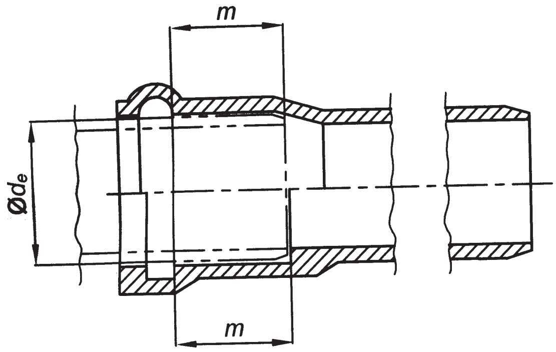


FIG. 5 DEPTH OF ENGAGEMENT

$$m_p = \frac{L \times \mu \times \sigma}{E_c}$$

where

L = length of pipe, in m;

μ = Poisson's ratio (0.45);

θ = hydrostatic stress in the circumferential direction, in MPa; and

E_c = elastic modulus in the circumferential direction (2.0 GPa).

σ is usually taken as the long-term operating stress at working pressure, or the design stress,$\acute{o}_s$ for the pipe material, and as the long-term creep modulus.

Example — For an MRS 500 pipe and $C = 1.6$, $\sigma_s = 32$ MPa, then:

$$m_p = (6 \times 0.45 \times 32)/2.0 = 43 \text{ mm}$$

For buried pipelines, resistance to contraction is offered by the soil and the full Poisson contraction is unlikely to be realized. However, an unrestrained above-ground pipeline can be subject to the full contraction. A worst-case situation arises during field testing of lines not yet back-filled, where a test pressure margin of 25 percent could be applied.

Example — With a short-term modulus of 4.0 GPa,

$$m_p = (6 \times 0.45 \times 32 \times 1.25)/4.0 = 27 \text{ mm}$$

C-2.3 Temperature Contraction

Shortening due to drop in temperature, m_t, in millimeters, is given as below:

$$m_t = L \times \alpha \times \Delta T \times 10^3$$

where

L = length of pipe, in m;

α = coefficient of linear expansion = (7×10^{-5}) °C^{-1}; and

ΔT = temperature differential, in °C.

This can occur, for example, during construction as a result of filling the pipeline with water. Again, for buried pipelines, soil friction will reduce the range of movement, but above ground lines could realize the full contraction. Some specifications also require an expansion gap to be allowed between the spigot and the back of the socket to accommodate a possible rise in temperature.

Example — A total temperature differential Δ T of 50 °C gives $m_t = 6 \times 7 \times 10^{-5} \times 50 \times 10^3 = 21$ mm.

C-2.4 Angular Deflection

Retraction of one side of the spigot due to angular deflection of the spigot within the socket, in millimetres, is given by:

$$m_a = \frac{d_e \times \pi \times \theta}{180}$$

where

θ = maximum angle of deflection of spigot within socket degrees.

Most parallel joints are capable of spigot/socket deflection of less than 1°.

Example — For a DN 315 joint, this gives $= 315 \times \pi/180 = 5$ mm.

Deflection joints can have greater capability and require proportionately more allowance.

C-2.5 Chamfer Length

Length of chamfer, c, in millimetres, shall be included in the available depth of engagement, as per the manufacturer's specification.

Example — For DN 315, $m_c = c = 25$ mm.

C-2.6 Safety Allowance (S)

For construction error, m_s.

Example — m_s= S = 20 mm.

C-2.7 The sum of the above allowances for a 6 m, DN 315 pipe,

$$m = m_p + m_t + m_a + m_s = 114 \text{ mm}$$

The standard engagement length according to IS 15328 is 118 mm.

Where full Poisson contraction can occur, this joint would be inadequate for a 12 m pipe length.

ANNEX D

(*Table* 12)

RING STIFFNESS OF PIPES

D-1 CALCULATION OF INITIAL RING STIFFNESS

For design purposes, the calculated initial ring stiffness of the pipes can be derived from Table 19.

Table 19 Initial Ring Stiffness of Pipes

(*Clause* D-1)

Sl No.	Class/C	Theoretical Minimum Stiffness, kN/m²				
		Nominal Pressure (PN)				
		10	12.5	16	20	25
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	450/1.4	1.6	3.1	6.3	12.1	25.2
ii)	450/1.6	2.2	4.4	8.5	17.5	34.5
iii)	500/1.4	-	2.2	4.4	8.5	17.5
iv)	500/1.6	1.6	3.1	6.3	12.1	25.2

These values are calculated from the formula:

$$S_{\text{calc}} = \frac{E \times I}{(d_{\text{n}} - e_{\text{n}})}$$

where

S_{calc} = calculated initial ring stiffness, in kN/m^2;

E = Young's modulus:

a) for pipe class 315, $E = 3.5 \times 10^6$ kN/m^2; and

b) for pipe class 355 and higher, $E = 4 \times 10^6$ kN/m^2; and

I = moment of inertia = $1/12\ e_{\text{n}}^3$, in cubic millimetre per metre (mm^3/m).

NOTE — The stiffness values are calculated on the basis of minimum wall thickness at any point $e_{y,min} = e_{\text{n}}$ (*see* **3.7**). Since the stiffness is a function of the mean wall thickness, it is statistically not possible for these values to be realized in practice, and the real stiffness will be significantly greater. For a tolerance of 15percent of wall thickness (Grade T), the mean could reasonably be expected to be around 5 percent over minimum, and the stiffness correspondingly 16 percent higher than the above results.

ANNEX E

(*Foreword and Clause* 9.4)

DETERMINATION OF AXIAL AND CIRCUMFERENTIAL ORIENTATION FACTOR

E-1 PRINCIPLE

A piece of pipe is measured under identical conditions before and after heating in the oven at a specified temperature for a specified duration.

The reversion is calculated as the percentage variation in length, diameter, and wall thickness in relation to the initial values. The test pieces are examined on any changes in appearance, for example bubbles and cracks.

E-2 METHOD

The axial and circumferential orientation factor shall be determined according to IS 12235 (Part 5/Sec 1 and Sec 2).

E-3 TEST PARAMETERS

Specimen length	:	300 mm
Distance between the marks	:	200 mm
Test temperature	:	150 ± 2°C
Medium	:	Air
Immersion time	:	60 or 120 min
Number of test pieces	:	3

E-4 TEST PROCEDURE

The test is carried out according to IS 12235(Part 5/Sec 1 and Sec 2).

The axial orientation factor, λ is calculated as:

$$\lambda a = \frac{L_{\text{o}}}{L_{\text{i}}}$$

where

L_{o} = measured length before conditioning, in mm; and

L_{i} = measured length after conditioning, in mm.

The circumferential orientation factor, λ_{c} is calculated as:

$$\lambda c = \frac{(D_{em} - e_{em})}{(D_i - e_i)}$$

where

D_{em} = measured outside diameter before conditioning, in mm;

D_i = measured outside diameter after conditioning, in mm;

e_{em} = mean wall thickness before conditioning, in mm; and

e_i = mean wall thickness after conditioning, in mm;

E-5 SAMPLING

Three test pieces are cut at random from the pipes.

ANNEX F

(*Clause* 11.3)

NEGATIVE PRESSURE CAPABILITY OF PIPES

F-1 Pipes can be subjected to unstable buckling under negative pressure conditions due to vacuum and/or external or groundwater pressure, if unsupported by soil or other lateral stiffening devices (*see* Table 20).

Table 20 Negative Pressure Capabilities of Pipes

(*Clause* F-1)

Sl No.	Class/C	Negative Pressure Capabilities of Pipes (P_{cr}) kPa Nominal Pressure (PN)				
		10	12.5	16	20	25
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	450/1.4	48	93	190	364	758
ii)	450/1.6	66	132	256	527	1038
iii)	500/1.4	–	66	132	256	527
iv)	500/1.6	48	93	190	364	758

These values have been calculated from the formula:

$$Pcr = \frac{24\ S_{calc}}{(1 - v^2)}$$

where

P_{cr} = unsupported critical buckling pressure, in kilopascals (kPa);

S_{calc} = calculated initial ring stiffness, in kN/m^2; and

v = Poisson's ratio, which can be assumed as 0.45.

NOTE — The critical buckling pressure may can likewise be expected to be around 16 percent higher than these values in practice. No other design coefficient is incorporated. When pipes are buried with cover exceeding two diameters, lateral soil support will increase buckling pressures significantly. Users should refer to appropriate engineering texts for advisory material.

ANNEX G

(*Clause* 13)

SAMPLING AND CRITERIA FOR CONFORMITY

G-1 ACCEPTANCE

Acceptance tests are carried out on samples selected from a lot for the purpose of acceptance of the lot.

G-1.2 Lot

All PVC-O pipes in a single consignment of the same grade, same nominal pressure, same size and manufactured under essentially similar conditions shall constitute a lot.

G-1.3 For ascertaining conformity of the lot to the requirements of the specification, samples shall be tested from each lot separately.

G-1.4 Visual and Dimensional Requirements

G-1.4.1 The number of test samples to be taken from a lot shall depend on the size of the lot and the outside diameter of the pipes, and shall be in accordance with Table 21.

G-1.4.2 These pipes shall be selected at random from the lot and in order to ensure the randomness of selection, a random number table shall be used. For guidance and use of random number tables, IS 4905 may be referred to. In the absence of a random number table, the following procedure may be adopted:

Starting from any pipe in the lot, count them as 1, 2, 3, etc, up to r and so on, where r is the integral part of N/n, where N being the number of pipes in the lot, and n the number of pipes in the sample. Every r^{th} pipe so counted shall be withdrawn so as to constitute the required sample size.

G-1.4.3 The number of pipes given for the first sample in col 4 of Table 21, shall be taken from the lot and examined for visual appearance, colour and dimensional requirements given in **7.1, 7.2** and **8**. A pipe failing to satisfy any of these requirements shall be considered as defective. The lot shall be deemed to have satisfied these requirements, if the number of defectives found in the first sample is less than or equal to the corresponding acceptance number given in col 6 of Table 21. The lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col 7 of Table 21. If, however, the number of defectives found in the first sample lies between the corresponding acceptance and rejection numbers given in col 6 and col 7, a second sample of the size given in col 4 shall be taken and examined for these requirements. The lot shall be considered to have satisfied these requirements, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number given in col 6, otherwise not.

G-1.5 Vicat Softening Test

G-1.5.1 The lot, having satisfied,the requirements for visual appearance and colour and dimensional requirements as per **G-1.4,** shall be tested for Vicat softening temperature in accordance with Sl No. (i) of Table 13.

G-1.5.2 For this purpose, the number of pipes given for the first sample in col 4 of Table 22 shall be taken from the lot. The sample pipe failing the Vicat softening test shall be considered as defective. The lot shall be deemed to have met the requirements given in this specification for the Vicat softening test , if the number of defectives found in the first sample is less than or

Table 21 Scale of Sampling for Visual Appearance, Colour and Dimensional Requirements
(*Clauses* G-1.4.1 *and* G-1.4.3)

Sl No. (1)	Number of Pipes in a Lot (2)	Sample Number (3)	Sample Size (4)	Cumulative Sample Size (5)	Acceptance Number (6)	Rejection Number (7)
i)	Up to 1 000	First	13	13	0	2
		Second	13	26	1	2
ii)	1 001 to 3 000	First	20	20	0	2
		Second	20	40	1	2
iii)	3 000 to 10 000	First	32	32	0	3
		Second	32	64	3	4
iv)	10 001 and above	First	50	50	1	4
		Second	50	100	4	5

equal to the corresponding acceptance number given in col 6. The lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col 6. If, however, the number of defectives in the first sample lies between the corresponding acceptance and rejection numbers given in col 6 and col 7, a second sample of size given in col 4 shall be taken and examined for the requirement. The lot shall be considered to have satisfied the requirements, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number given in col 6, otherwise not.

G-1.6 Density

G-1.6.1 The lot, having satisfied,the requirements for visual appearance and colour and dimensional requirements as per **G-1.4**, shall be tested for density in accordance with **5.5**.

G-1.6.2 For this purpose, the procedure adopted for sampling and criteria for conformity shall be the same as that given in Table 22.

G-1.7 Resistance to External Blows at 0 °C

G-1.7.1 The lot, having been found satisfactory according to **G-1.4**, **G-1.5** and **G-1**.**6**shall be tested for resistance to external blows at 0°C as per **9.2**.

G-1.7.2 For this purpose, the procedure adopted for sampling and criteria for conformity shall be as specified in Annex C of IS 4985 and Table 23.

G-1.8 Resistance to Internal Hydrostatic Pressure Test (Acceptance Test) and Short Term Negative Pressure Test for Leak Tightness of Assemblies

G-1.8.1 The lot, having been found satisfactory according to **G-1.4**, **G-1.5, G-1.6** and **G-1.7** shall be subjected to the requirements of the acceptance test for resistance to internal hydraulic pressure [*see* Sl No. (i) of Table 10] and short-term negative pressure test for leak-tightness of assemblies (*see* **11.3**). The number of pipes to be taken from the lot shall depend on the size of the lot and shall be according to Table 24.

G-1.8.2 The pipes shall be taken at random from the lot. In order to ensure the randomness of selection, procedures given in IS 4905 may be followed.

G-1.8.3 *Number of Tests and Criteria for Conformity*

The number of test samples shall be as given in Table 24. The lot shall be considered to have satisfied the requirements for this test, if the number of test samples failing in this requirement is equal to the corresponding acceptance number given in col 4 of Table 24.

G-1.9 RESISTANCE TO DI-CHLOROMETHANE

The lot having satisfied the requirements for visual appearance and colour and dimensional requirements as per **G-1.4** shall be tested for resistance to dichloromethane as per Sl No. (iii) of Table 13. For this purpose sub-sample from those already tested and satisfying the requirements of **G-1.4** shall be drawn as given in col 5 of Table 24 or Table 25, as appropriate for the first/second sample size. The lot shall be deemed

Table 22 Scale of Sampling for Vicat Softening Temperature and Density Test
(*Clauses* G-1.5.2 *and* G-1.6.2)

Sl No. (1)	Number of Pipes in a Lot (2)	Sample Number (3)	Sample Size (4)	Cumulative Sample Size (5)	Acceptance Number (6)	Rejection Number (7)
i)	For d_n up to and including 110 mm:					
a)	Upto 1 000	First	5	5	0	2
		Second	5	10	1	2
b)	1 001 to 3 000	First	8	8	0	2
		Second	8	16	1	2
c)	3 000 to 10 000	First	13	13	0	2
		Second	13	26	1	2
d)	10 001 and above	First	20	20	0	3
		Second	20	40	3	4
ii)	For d_n above 110 mm:					
a)	Up to 3 000	First	3	3	0	2
		Second	3	6	1	2
b)	3 001 to 10 000	First	5	5	0	2
		Second	5	10	1	2
c)	10 001 and above	First	8	8	0	2
		Second	8	16	1	2

Table 23 Scale of Sampling for Resistance to External Blows at 0°C
(*Clause* G-1.7.2)

Sl No. (1)	Number of Pipes in a Lot (2)	Sample Number (3)	Sample Size (4)	Cumulative Sample Size (5)	Acceptance Number (6)	Rejection Number (7)
i)	Upto 3 000	First	3	3	0	2
		Second	3	6	1	2
ii)	3 000 to 10 000	First	5	5	0	2
		Second	5	10	1	2
iii)	10 001 and above	First	8	8	0	2
		Second	8	16	1	2

NOTE — The numbers mentioned in col 4 to col 7 represent the number of times the test is to be carried out and do not represent either the number of pipe samples or number of blows or number of failures.

Table 24 Scale of Sampling for Internal Hydrostatic Test
(*Clauses* G-1.8.1 *and* G-1.8.3)

Sl No. (1)	Number of Pipes in a Lot (2)	Sample Size (3)	Acceptance Number (4)
i)	Upto 3 000	2	0
ii)	3001 to 10 000	3	0
iii)	10 001 and above	5	0

to have met the requirements given in the corresponding acceptance number given in col 6 of Table 24 or Table25, as relevant. The lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col 7 of Table 24 or Table 25. If however the number of defectives found in the first samples lies between corresponding acceptance and rejection number given in col 6 and col 7 of Table 24 or Table 25, a second sample size given in col 4 of Table 24 or Table 25 shall be taken and examined for requirements. The lot shall be considered to have satisfied the requirements, if number of defective found in the cumulative sample is less than or equal to the corresponding acceptance number given in col 6 of Table 24 or Table 25, as appropriate, otherwise not.

G-1.10 UNIAXIAL TENSILE STRENGTH

G-1.10.1 Number of Test Specimens

For this purpose, the procedure adopted for sampling shall be as per **G-1.9** and the test shall be performed as per Sl No. (iv) of Table 13. However, the number of sub-samples to be selected and criteria for conformity shall be as per Table 27.

G-1.11 Ring Stiffness Test

The lot having satisfied the requirements for visual appearance and colour and dimensional requirements as per **G-1.4** shall be tested for requirements of ring stiffness as per **9.3**. The number of pipes to be taken from the lot shall depend on the size of the lot and shall be according to Table 28. If the first sample drawn fails the test, resampling should be done from the lot which has satisfied the dimensional and visual requirements. The lot shall be considered to have met the requirements of these tests, if none of these samples tested fails

G-2 TYPE TESTS

G-2.1 Type tests are intended to prove the suitability and performance of a new composition or a new size of pipe. Such tests, therefore, need to be applied only when

Table 25 Scale of Sampling for Resistance to Dichloromethane Tests (For DN upto and Including 110 mm)
(*Clause* G-1.9)

Sl No. (1)	Number of Pipes in a Lot (2)	Sample Number (3)	Sample Size (4)	Cumulative Sample Size (5)	Acceptance Number (6)	Rejection Number (7)
i)	Upto 1 000	First	5	5	0	2
		Second	5	10	1	2
ii)	1 001 to 3 000	First	8	8	0	2
		Second	8	16	1	2
iii)	3 000 to 10 000	First	13	13	0	2
		Second	13	26	1	2
iv)	10 001 and above	First	20	20	0	3
		Second	20	40	3	4

Table 26 Scale of Sampling for Resistance to Dichloromethane Tests (For DN above 110 mm)
(*Clause* G-1.9)

Sl No.	Number of Pipes in a Lot	Sample Number	Sample Size	Cumulative Sample Size	Acceptance Number	Rejection Number
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Upto 3 000	First	3	3	0	2
		Second	3	6	1	2
ii)	3 000 to 10 000	First	5	5	0	2
		Second	5	10	1	2
iii)	10 001 and above	First	8	8	0	2
		Second	8	16	1	2

a change is made in polymer composition or when a new size of pipe is to be introduced. Type tests for compliance with **G-2.2, G-2.3** and **G-2.4** shall be carried out.

G-2.2 Opacity

For this test, the manufacturer or the supplier shall furnish to the testing authority, one sample of the pipe of the thinnest wall section, selected preferably from a regular production lot.

G-2.2.1 The sample so selected shall be tested for compliance with requirements for opacity as given in **7.3**.

G-2.2.2 If the sample passes the requirements of the opacity test, the type of the pipe under consideration shall be considered to be eligible for approval, which shall be valid for a period of one year.

G-2.2.3 In case the sample fails in the test, the testing authority, at its discretion, may call for a fresh sample and subject the same to the opacity test. If the sample passes the repeat test, the type of pipe under consideration shall be considered eligible for approval. If the sample fails in the repeat test, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

G-2.2.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for a fresh sample for opacity test for the purpose of type approval.

G-2.3 Resistance to Internal Hydrostatic Pressure Test (Type Test)

For this type test, the manufacturer or the supplier shall furnish to the testing authority, three samples of pipes of different diameters and different classes (selected preferably from a regular production lot).

G-2.2.1 Three samples so selected shall be tested for compliance with the requirements of type test given in Sl No. (ii) of Table 10.

G-2.2.2 If all the three samples pass the requirements of the quality test, the type of pipe under consideration shall be considered to be eligible for type approval which shall be normally valid for a period of one year.

G-2.2.3 In case any of the samples fail in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to the type test. If, in the repeat test, no single failure occurs, the type of pipe shall be considered for type approval. If any of the samples fails in the repeat tests, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

G-2.2.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for type test for the purpose of type approval

Table 27 Scale of Sampling for Uniaxial Tensile Test (For DN 40 to 315 mm)
(*Clause* G- 1.10.1)

Sl No.	Number of Pipes in the Lot	Sample Number	Sample Size	Cumulative Sample Size	Acceptance Number	Rejection Number
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Up to 3 000	First	3	3	0	2
		Second	3	6	1	2
ii)	3001 to 10 000	First	5	5	0	2
		Second	5	10	1	2
iii)	10 001 and above	First	8	8	0	2
		Second	8	16	1	2

Table 28 Scale of Sampling for Ring Stiffness Test

(*Clause* G-1.11)

Sl No.	No. of Pipes in Lot	Sample Size for Sizes Less than or Equal to 500 mm	Sample Size for Sizes Greater than 500 mm
(1)	(2)	(3)	(4)
i)	Up to 1 000	2	1
ii)	1 001 to 3 000	3	2
iii)	3 001 and above	4	3

G-2.3 Test for Effect on Water

For this type test, the manufacturer or the supplier shall furnish to the testing authority three samples of the smallest size of pipe taken from each machine (selected preferably from a regular production lot).

G-2.3.1 Three samples so selected shall be tested for compliance with the requirements for effect on water as given in Sl No. (ii) of Table 13.

G-2.3.2 If all three samples pass the requirements for effect on water, the type test of the pipe under consideration shall be considered to be eligible for approval, which shall be normally valid for a period of one year.

G-2.3.3 In case any of the samples fails in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number, and subject them to the test for effect on water. If, in the repeat test, no single failure occurs, the type of pipe under consideration shall be considered eligible for type approval. If any of the samples fails in the repeat test, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

G-2.3.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for effect on water test for the purpose of type approval.

G-2.4 Short-Term Pressure Test for Leak Tightness of Assemblies and Long Term Pressure Test for Leak Tightness of Assemblies

G-2.4.1 For this test, the manufacturer or the supplier shall supply furnish to the testing authority, three samples of pipes of different diameters and different classes, selected preferably from a regular production lot.

G-2.4.2 Three samplesso selectedshall be tested for compliance with the requirements of the test given in **11.2** and **11.4**.

G-2.4.3 If all the three samples pass the requirements of the quality test, the type of pipe under consideration shall be considered to be eligible for approval, which shall be normally valid for a period of one year.

G-2.4.4 In case any of the samples fail in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to the type test. If, in the repeat test, no single failure occurs, type of pipe shall be considered for type approval. If any of the samples fails in the repeat tests, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

G-2.4.5 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

ANNEX H

(*Foreword*)

GUIDELINES FOR STORAGE AND INSTALLATION

H-1 STORAGE

The following guidelines for storage of PVC-O pipes is suggested:

a) Store the pipes horizontally on a flat surface and place supports every 1.5 m to avoid the bending of the product.

b) Avoid scratches especially in the crest of the socket, due to dragging the pipe on the ground, mainly if the surface is made of stone, concrete or asphalt.

c) Do not stack pipes more than 1.5 m height, as this can damage lower pipes or even the upper pipes can fall.

d) The sockets should be free, alternating sockets and ends.

e) In case of prolonged sun exposure, protect pallets with an opaque material. White colour is preferable because it avoids the over-heating of the pipes.

H-2 REALIZATION OF THE TRENCH

The trench shall be free of stones at the bottom and at the sides. Stones smaller than 10 - 20 mm are allowed, but it cannot be the main size of the ground particles. Minimum width of the trench based on nominal diameter of pipes to be laid and/or depth of trench is specified in Table 29 and Table 30, respectively.

As a rule of thumb, when there is no road traffic involved, the pipes crown will be at a minimum depth of 0.6 m; with road traffic, the minimum depth is 1 m.

Table 29 Minimum Trench Width Based on Nominal Diameter of Pipes

(*Clause* H-2)

Sl No.	Nominal Diameter, d_n mm	Minimum Width of Trench m
(1)	(2)	(3)
i)	90 to 250	0.60
ii)	315	0.85
iii)	355	1.00
iv)	400	1.10
v)	450	1.15
vi)	500	1.20
vii)	630	1.35
viii)	800	1.65
ix)	1 000	1.80
x)	1 200	2.00

Table 30 Minimum Trench Width Based on Depth of Trench

(*Clause* H-2)

Sl No.	Depth of Trench, *h* m	Minimum Width of Trench m
(1)	(2)	(3)
i)	$h < 1.00$	0.60
ii)	$1.00 \leq h < 1.75$	0.80
iii)	$1.75 \leq h < 4.00$	0.90
iv)	$h \geq 4.00$	1.00

H-3 BEDDING AND FILLING THE TRENCH

Pipes should be installed following the guidelines given below:

a) Before placing the pipe, a sand bed should be prepared (a fine granular material may be used instead of sand) with a thickness from 10 cm to 15 cm. The pipe should be well aligned and levelled.

b) The pipe shall lie on the sand bed. It shall be ensured that all the lower part of the pipe is settled on the sand bed trying to soak as much as possible in order to make the angle of sand that supports the kidneys of the pipe as big as possible.

c) Once the pipe is placed, chamberlain sides shall be filled with the selected material and compacted to achieve >95 percent Proctor normal (P.N.).

d) The trench shall be filled with the selected material and compacted laterally until the upper part of the pipe is buried at least 30 cm.

e) Steps (a) and (d) can be done with the same natural material obtained from the excavation, trying to avoid rocks and large stones, and checking that this natural material can support the forces produced by the pressure inside of the pipe.

Natural soil can be used as the selected filler material whenever it fulfils the following criteria:

1) The filler material should not consist of angular stones or similar material.

2) Filler material should not contain bigger particles than the ones shown in Table 31.

3) Filler material should not contain blocks of soil twice the size of the maximum dimensions of the particles given in the Table 31.

Table 30 Maximum Particle Size

(*Clause* H-3)

Sl No.	Nominal Diameter d_n mm	Maximum Particle Size mm
(1)	(2)	(3)
i)	$d_n < 100$	15
ii)	$100 \le d_n < 300$	20
iii)	$300 \le d_n < 600$	30
iv)	$d_n \ge 600$	40

4) From 30 cm above the pipe until the surface of the ground, the trench can be filled with natural material not specifically selected and compacting directly over the whole surface of the trench.

The typical section showing various stages of bedding and filling the trench is shown in Fig. 6.

H-4 ASSEMBLY

a) Remove the protection caps (if any).

b) Verify that the pipe is clean and in good condition. Paying attention to the sockets and spigot ends.

c) Check that the chamfer is correct and free of cracks.

d) Verify that the seal is in its place, clean and free of foreign materials (stones, sand, etc).

e) Lubricate the chamfer of the spigot and the seal with joint lubricant.

f) Line up the pipe as much as possible horizontal and vertically.

g) Insert only the chamfer edge of the socket, just to support the pipe but leaving the socket lip free.

h) In the case of pipes with nominal diameter $d_n \le 250$ mm, a firm and dry push should be given to seize the momentum produced by the free movement in the lip of the socket and introduce it until the mark is hidden into the socket.

j) When installing diameters >250 mm, one should use mechanical means to introduce the pipe using materials such as wood, hoists, tackles or slings.

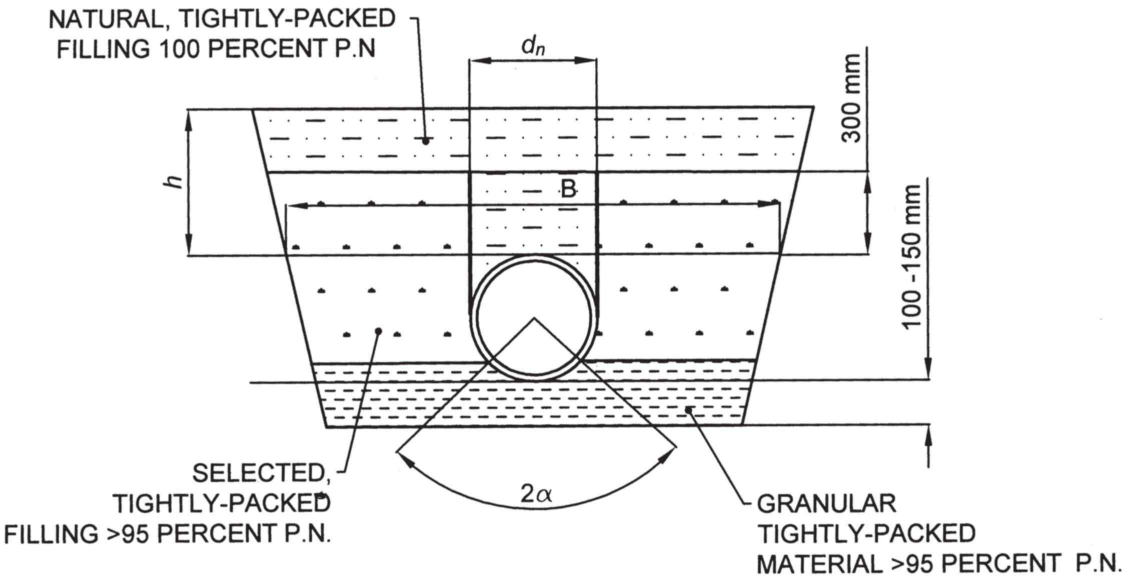

NATURAL, TIGHTLY-PACKED FILLING 100 PERCENT P.N
d_n
300 mm
h
B
100 -150 mm
SELECTED, TIGHTLY-PACKED FILLING >95 PERCENT P.N.
2α
GRANULAR TIGHTLY-PACKED MATERIAL >95 PERCENT P.N.

FIG. 6 TYPICAL SECTION OF BEDDING AND FILLING THE TRENCH

ANNEX J

(*Foreword*)

COMMITTEE COMPOSITION

Plastic Piping System Sectional Committee, CED 50

Organization	*Representative(s)*
Central Institute of Plastic Engineering and Technology, Chennai	Dr S. K. Nayak (***Chairman***)
Borouge India (P) Ltd, Mumbai	Shri Prashant D. Nikhade
Brihan Mumbai Licensed Plumbers'Association, Mumbai	Shri P. A. Vartak Shri H.G. Gandhi (*Alternate*)
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AMENDMENT NO. 1 JUNE 2021

TO

IS 16647 : 2017 ORIENTED UNPLASTICIZED POLYVINYL CHLORDE (PVC-O) PIPES FOR WATER SUPPLY — SPECIFICATION

(*Page* 1, *clause* **1.1**, *line* 6) — Substitute ‘minimum’ for ‘maximum’.

(*Page* 3, *clause* **5.3**, *line* 2) — Substitute ‘**4.4.1**’ *for* ‘**3.3.1**’.

(*Page* 3, *clause* **7.3**) — Insert the following at the end of the clause:

‘The convex (outer) surface of the pipe specimen shall face the light source.’

(*Page* 8, *Table* 10, *col* 5 and 6, Heading) — Insert ‘*Min*,’ between ‘Hoop Stress,’ and ‘σ’.

(*Page* 8, *clause* **9.2**, *para* 2, *line* 3) — Substitute ‘root’ for ‘route’.

[*Page* 9, *Table* 13, *col* 2, *Sl No.* (ii)] — Substitute ‘Effect on water (*see* NOTE)’ *for* ‘Effect on water’.

[*Page* 9, *Table* 13, *col* 3, *Sl No.* (ii)] — Substitute ‘As per **10.3** and **10.3.1** of IS 4985’ *for* ‘As per IS 4985’.

(*Page* 9, *Table* 13) — Insert the following Note above footnote [1]:

‘NOTE — Implementation of the phase out programme for use of lead stabilizers in PVC pipe and fitting manufacturing of Government of India shall be borne in mind.’

(*Page* 11, *clause* **14.1.1**) — Substitute the following for the existing:

‘**14.1.1** The batch number shall include the details of production in the following manner:

Year	Month	Day	Machine No.	Shift
xxxx	xx	xx	xxx	x

’

(*Page* 11, *clause* **14.2**) — Substitute the following for the existing:

‘14.2 BIS Certification Marking

The pipes conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the pipes may be marked with the Standard Mark.’

(*Page* 12, Annex A) — Substitute the existing entry for IS 4985 by the following:

‘*IS No.*	*Title*
4985 : 2021	Unplasticized PVC pipes for water supplies — Specification (*fourth revision*)’

(*Page* 12, Annex A) — Substitute the existing entry for IS 10151 by the following:

‘*IS No.*	*Title*
10151 : 2019	Polyvinyl chloride (PVC) and its copolymers for its safe use in contact with foodstuffs, pharmaceuticals and drinking water — Specification (*first revision*)’

(CED 50)

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